PacifiCorp
Wyodak Power Plant

48 Wyodak Road
Garner Lake Route
Gillette, WY 82718
(307) 686-1248

January 21, 2000

Mr. William Grimley
Emissions Measurement Center
Interstate 40 and Page Road
4930 Old Page Road
Room Number E-108
Durham, NC 27709

Attn: Electric Utility Steam Generating Unit Mercury Test Program

Dear Mr. Grimley:

Please find enclosed three copies of the Mercury Emission Test Report for Pacificorp's Wyodak Plant BW91.

Should you have any questions or concerns regarding this submittal, please contact Bernadette Hinshaw at (307) 687-4283.

Sincerely,

Gregory L. Hager
Plant Manager

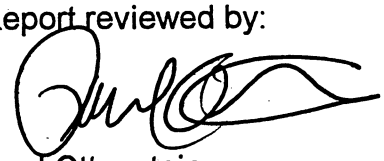
AIR
POLLUTION
TESTING, INC.
DENVER, SALT LAKE CITY

Source Emissions Testing
Report for PacifiCorp:
Wyodak Plant
Gillette, Wyoming

Mercury Testing

Report prepared for:
PacifiCorp Environmental Services
1407 West North Temple
Salt Lake City, Utah 84140

Report reviewed by:



Paul Ottenstein
Technical Director

Test Dates:
September 29 and 30, 1999

APT Project Number: PAC9137

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Table of Contents

1. Introduction..... 1

2. Methods..... 2

3. Test Program Summary..... 2

4. Sampling and Analysis Details..... 5

4.1. Sampling Details..... 5

4.2. Quality Assurance / Quality Control..... 8

4.3. Problems..... 8

4.4. Additional Notes..... 10

5. Results..... 10

Tables

Table 1.1 : Emissions Testing Program Contact Personnel..... 1

Table 3.1 : Sampling and Analytical Methods Summary..... 3

Table 5.1 : Testing Results..... 11

Diagrams

Diagram 3.1 : Scrubber Exhaust Sampling Location Schematic..... 3

Diagram 3.2 : Scrubber Inlet Sampling Location Schematic..... 4

Diagram 4.1 : Sampling Train Schematic..... 7

Appendices

Testing Parameters / Sample Calculations..... Appendix 1

Field and Laboratory Data..... Appendix 2

Calibration Data and Certificates..... Appendix 3

Operating Data and Coal Analysis Results..... Appendix 4

1. Introduction

Air Pollution Testing (APT) was contracted by Pacificorp to conduct a series of source tests on the inlet and outlet of Wyodak Station's Unit #1 dry scrubber. The purpose of the testing program was to determine the operating efficiency of the dry scrubber for removal of particulate matter (PM) and elemental, oxidized and particle-bound mercury (Hg) from the flue gas. The testing was conducted as part of the U.S. Environmental Protection Agency (USEPA) Part III Mercury Information Collection Effort.

At Unit #1 inlet and outlet sampling locations, triplicate 120-minute sampling periods were conducted on September 29 and 30, 1999 while the unit maintained a load of approximately 380 MW.

The following table provides key project personnel, company affiliations, telephone and fax numbers.

PacifiCorp : Wyodak Station Unit #1 Mercury Testing Emissions Testing Program Contact Personnel		
Name, Title	*Company Address*	*Phone, FAX*
Frank Zampedri, Senior Environmental Analyst	PacifiCorp Environmental Services 1407 West North Temple Salt Lake City, Utah 84140	801-220-2169, 801-220-4307
Bernadette Hinshaw, Environmental Engineer	PacifiCorp Wyodak Plant 48 Wyodak Road Gillette, Wyoming 82718-8202	307-687-4283, 307-687-4293
Paul Ottenstein, Program Manager David Stewart, Project & QA Manager	Air Pollution Testing, Inc. 12421 West 49th Avenue, Unit #2 Wheat Ridge, Colorado 80033	303-420-5949, 303-420-5920
Dr. Ron McLeod, Principal Scientist	Philip Analytical Services 5555 North Service Road Burlington, Ontario L7L 5H7 Canada	905-332-8788 x 236, 905-332-9165

Table 1.1: Emissions Testing Program Contact Personnel

2. Methods

APT tested in accordance with the following U.S. Environmental Protection Agency (EPA) and ASTM source emissions test methods. Methods 1 through 5 and 17 are referenced in *40 CFR Part 60, Appendix A*. The Ontario Hydro Method is a draft method currently being reviewed by ASTM Committee D-22 on Sampling and Analysis of Atmospheres, Subcommittee D22.03 on Ambient Atmospheres and Source Emissions.

- *Method 1 - Sample and Velocity Traverses for Stationary Sources*
- *Method 2 - Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)*
- *Method 3 - Gas Analysis for the Determination of Dry Molecular Weight*
- *Method 4 - Determination of Moisture Content in Stack Gases*
- *Method 5 - Determination of Particulate Emissions from Stationary Sources*
- *Method 17 - Determination of Particulate Emissions from Stationary Sources (In-Stack Filtration Method)*
- *Draft Method - Standard Test Method for Elemental, Oxidized, Particle-Bound and Total Mercury in the Flue Gas Generated from Coal-Fired Stationary Sources (Ontario Hydro Method)*

3. Test Program Summary

The test program determined all parameters detailed in Table 3.1. At each sampling location, integrated samples were collected for off-site analysis to determine the speciated Hg and PM content of the gas streams. All samples were collected by APT personnel and delivered to Philip Analytical Services Corporation (PASC) in Ontario, Canada via overnight delivery. The sampling locations and sampling points are illustrated in Diagrams 3.1 and 3.2.

At the inlet location, an in-stack filter (Method 17) and teflon probe were used for sample collection. At the outlet (stack) location, the lower flue gas temperature required on out-of-stack filter (Method 5) and glass probe for sample collection.

PacifiCorp : Wyodak Station Unit #1 Mercury Testing Sampling and Analytical Methods Summary			
Parameter	*Sampling Method*	*Analytical Method*	*Laboratory*
Gas Flow	Methods 1 and 2	draft gauge, S-type pitot tube	APT On-Site
Oxygen, Carbon Dioxide (O_2, CO_2)	Method 3	wet chemical (Orsat)	
Moisture (H_2O)	Method 4	gravimetric	
Particulate Matter	Method 5 and 17	gravimetric	PASC Burlington, Ont
Speciated Mercury	Ontario Hydro Method	cold vapor atomic absorption (CVAAS)	

Table 3.1: Sampling and Analytical Methods Summary

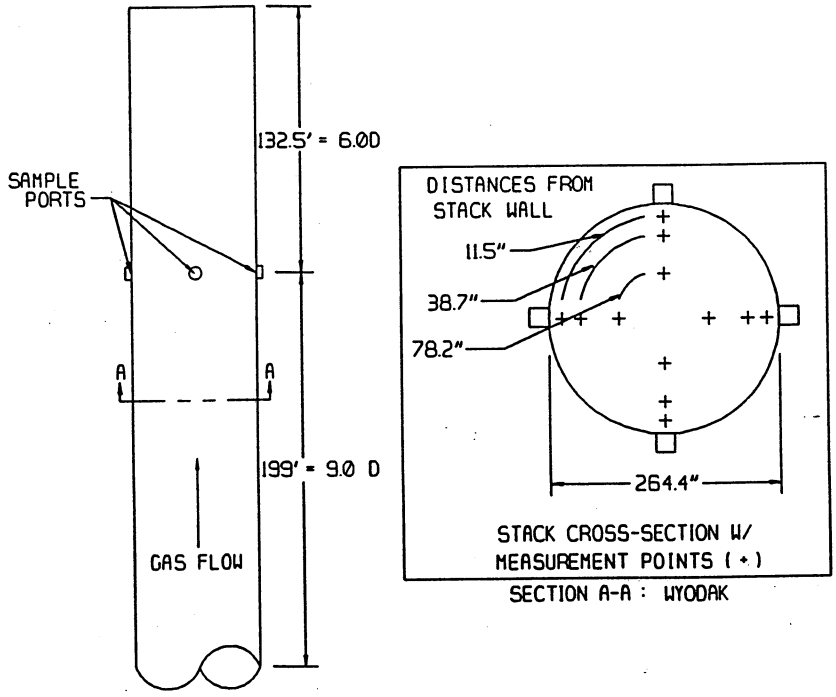
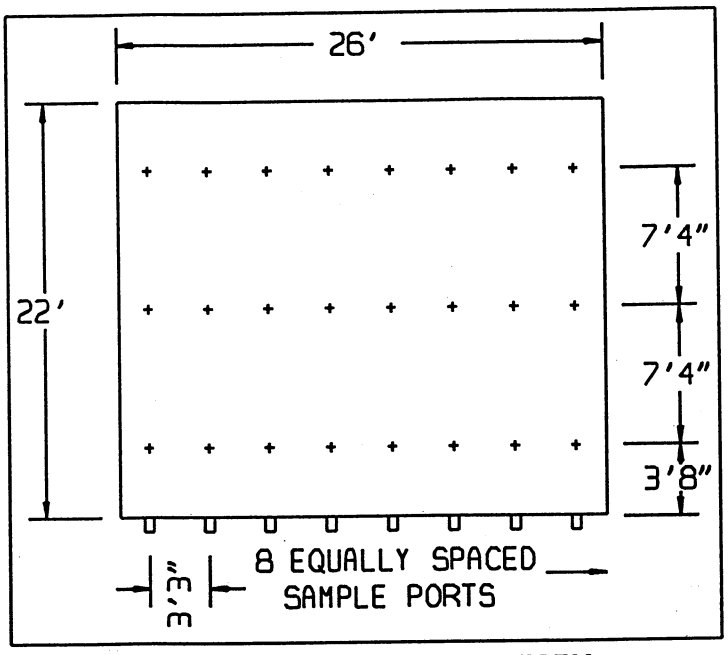


Diagram 3.1: Scrubber Exhaust Sampling Location Schematic (not to scale)



SECTION A-A: DUCT CROSS SECTION
W/ SAMPLE POINTS (+)

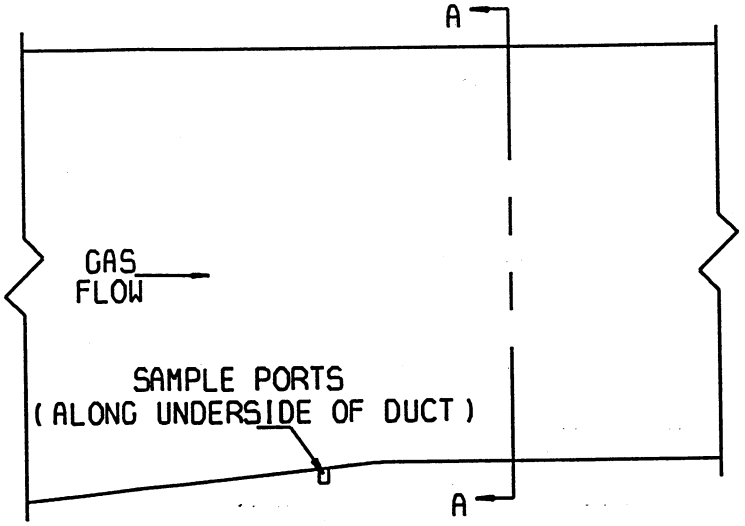


Diagram 3.2: Scrubber Inlet Sampling Location Schematic (not to scale)

4. Sampling and Analysis Details

4.1. Sampling Details

Gas flow rate, PM, and speciated Hg levels were determined in accordance with EPA Methods 1, 2, 3, 4, 5 (stack) or 17 (inlet), and ASTM Method D-22 Ontario Hydro Method. A summary of the testing parameters is provided in *Appendix 1 - Testing Parameters / Sample Calculations*. Copies of the field and laboratory data sheets are located in *Appendix 2 - Field and Laboratory Data*. Diagram 4.1 provides a schematic of the sampling train used at the scrubber stack. The scrubber inlet sampling train was similar, with the changes described below.

Each sampling period consisted of conducting a temperature and differential pressure traverse of the duct with a K-type thermocouple and an S-type pitot tube. Concurrently, a gas sample was extracted at an isokinetic flow rate.

At the stack, the gas passed through a glass in-stack nozzle, a heated glass probe liner, across a heated quartz fiber filter, through a series of 8 chilled glass impingers, and through a calibrated dry gas meter. An integrated gas sample was collected in a Tedlar bag. The average stack gas temperature was 179°F. Accordingly, the probe liner and filter housing were maintained at 120°C (248°F) throughout the sampling.

At the scrubber inlet, a teflon-coated, in-stack filter holder assembly was used in place of the out-of-stack filter used at the stack. Additionally, the probe liner material downstream of the filter assembly was changed to teflon. The filter assembly contained a quartz thimble style filter backed up in series with a flat, 47 mm quartz filter. The scrubber inlet gas stream average temperature was 320°F. The teflon probe liner was maintained at 120°C (248°F) throughout the sampling.

Prior to sampling, the first three impingers were each seeded with 100 milliliters (ml) of potassium chloride (KCl). The fourth impinger was seeded with nitric peroxide (HNO_3/H_2O_2). The fifth, sixth, and seventh impingers were each seeded with 100 ml of acidified potassium permanganate ($KMnO_4$). The eighth impinger was seeded with approximately 250 grams of dried silica gel.

Following sampling, the moisture gain in the impingers was measured gravimetrically to determine the moisture content of the stack gas. The filters and a series of acetone rinses of the nozzle and sampling hardware upstream of the filters were quantitatively recovered for gravimetric analysis to determine the

PM and particulate Hg content of the gas streams. The impinger contents were recovered according to the procedures provided in the Ontario Hydro Method to determine the oxidized and elemental Hg content of the gas streams. The contents of the Tedlar bags were analyzed for oxygen and carbon dioxide content using an Orsat apparatus.

All of the above data were combined to calculate the gas velocity and volumetric flow rate in units of feet per second (ft/sec), actual cubic feet per minute (acfm), dry standard cubic feet per minute (dscfm), and pounds per hour (lb/hr). The PM levels were calculated in units of grains per dry standard cubic foot (gr/dscf) and lb/hr. Each Hg fraction (particulate bound, oxidized, elemental and total) was calculated in units of micrograms per dry standard cubic meter (µg/dscm) and lb/hr.

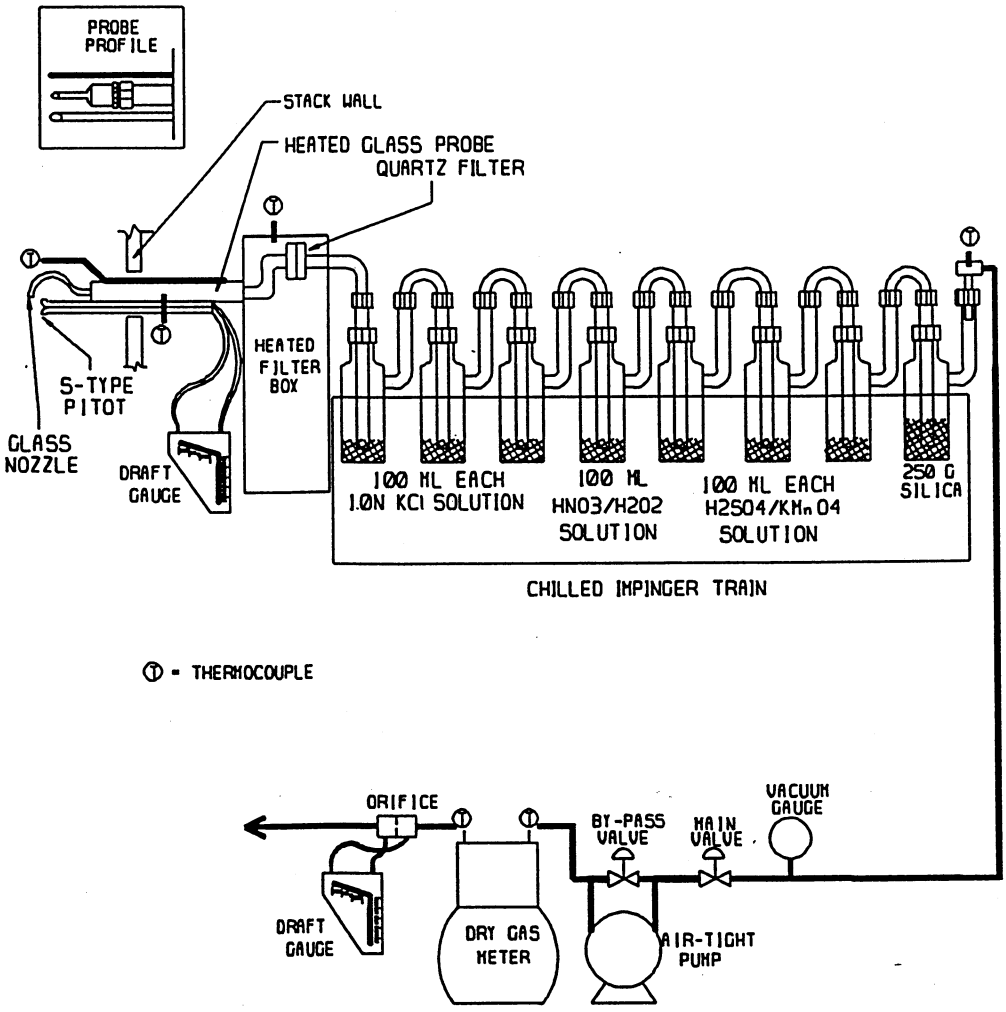


Diagram 4.1 : EPA Methods 1 - 5 and Ontario Hydro Speciated Mercury Sampling Train Schematic

4.2. Quality Control / Quality Assurance

A mobile analytical trailer prepared and dedicated for the project was provided to maintain a clean, temperature controlled environment for sample train preparation and sample recovery. The trailer was located by the inlet sampling location.

4.2.1. Pre-Mobilization Quality Assurance Samples

Prior to departure for the test program, filters and aliquots of all reagents were analyzed for Hg. These analyses all indicated acceptably low background levels of mercury. All glassware was washed in accordance with the Ontario Hydro Method recommended procedures. Following this washing, a final rinse was conducted with 0.1N HNO_3. This final rinse solution was recovered and remains on hold at Philip Analytical for future analysis if glassware contamination is questioned.

4.2.2. On-Site Quality Assurance Samples

Solution, filter and field blanks were collected during the field sampling. No mercury was detected in any solution blank or any field blank fraction. A low level of background mercury was detected in the filter blank for the Method 5 (outlet) filter. The Ontario Hydro Method does not provide a specification for acceptable mercury background in the filter blank. However, the detected level was approximately 2% of the acceptable maximum mercury background for EPA Method 29. The outlet particulate mercury values were blank corrected in accordance with the method.

A field blank was collected at the inlet sampling location during the testing campaign. Field blank collection procedures were as detailed in the Ontario Hydro Method. No mercury was detected in any fraction of the field blank. A field blank was not collected at the outlet location due to access constraints at the tight sampling location. The complete lack of mercury in the inlet field blank (the substantially dirtier location of the two) should provide adequate quality assurance with respect to field blanks.

4.3. Problems

4.3.1. Sample Breakage

During shipping, two containers were broken. The containers were Inlet Run #3

Container #2A (acetone probe wash) and Inlet Run #3 Container #4 (HNO_3/H_2O_2 impinger contents).

4.3.1.1. Inlet Run #3 Container #2A

Container #2A is a component of the probe rinse mercury fraction (along with Container #2, the nitric acid probe wash), which is a component of the particulate mercury value (along with Container #1, the filter). In the mercury analysis report, Container #2 and #2A are reported together, so the Inlet Run #3 value reported by the laboratory as "probe rinse" is Container #2 only.

For the Inlet Run #1 sample, the probe rinse accounted for 4% of the total particulate mercury. For the Inlet Run #2 sample, the probe rinse accounted for less than 0.3% of the total particulate mercury (no mercury was detected in the probe rinse). The loss of this sample fraction for Inlet Run #3 is expected to result in a small negative bias in the particulate mercury for Inlet Run #3.

4.3.1.2. Inlet Run #3 Container #4

Container #4 is a component of the elemental mercury catch (along with Container #5, the $H_2SO_4/KMnO_4$ impinger contents).

For the Inlet Run #1 sample, Container #4 accounted for less than 3% of the elemental mercury catch. For the Inlet Run #2 sample, Container #4 accounted for just over 3% of the elemental mercury catch. The loss of this sample fraction for Inlet Run #3 is expected to result in a small negative bias in the elemental mercury for Inlet Run #3.

4.3.2. Access Constraints

The outlet sampling location did not allow for the probe and sampling train to be completely assembled prior to entry into the port. This was due to a three foot distance from the port to the stack annulus inner wall. To maneuver the sampling train from port to port, the probe had to be disassembled from the rest of the train. Leak checks were performed at the end and beginning of each port change. The sample integrity is not believed to have been diminished by this activity. This limited sampling space also prevented collection of a field blank at the outlet location (see section 4.2.2.).

4.3.3. Analytical Hold Times

All impinger portions of all sample runs were analyzed within the 45 day recommended hold time. The front half (particulate) fractions were analyzed within 48 - 49 days of sampling. No loss of mercury from these non-volatile sample fractions is likely, and no impact on the data quality is suspected. See the laboratory report in *Appendix 2 - Field and Laboratory Data* for details.

4.4. Additional Notes

4.4.1. Scrubber Outlet Particulate Results

There is relatively poor consistency in the particulate results at the scrubber outlet. This may be a result of using different balances for the tare and final weights. The filters were tared at the APT Wheat Ridge, Colorado facility. To expedite analysis, final weights were taken at the Philip Analytical facility in Ontario Canada. Identical procedures were employed on the inlet samples, but the substantially larger net mass gains washed out any inter-balance effects.

4.4.2. Calculations

For pollutant sample fractions with "not detected" mercury values, the detection limits were used for calculations. For solution blank fractions with "not detected" mercury values, zero was used for calculations. This provides maximum possible mercury values for all pollutant samples. It is only of potential significance for the outlet particulate mercury samples. For these samples, the detection limit for the "not detected" probe rinse fractions was more than double the detected levels on the filters. It is believed that using the detection limit for the probe rinses biases these values high.

5. Results

The results of the testing are presented in Table 5.1. Any testing parameters not found in the table may be found in *Appendix 1 - Testing Parameters / Sample Calculations*. The following terms and abbreviations are used in the table.

kdscfm - thousands of dry standard (68°F, 1 atm.) cubic feet per minute
temp. - temperature
gr/dscf - grains per dry standard cubic foot
ug/dscm - micrograms per dry standard cubic meter
lb/hr - pounds per hour

PacifiCorp : Wyodak Station Unit #1 Mercury Testing
Test Results

gas parameter	Scrubber Inlet				Scrubber Outlet - Stack				Control Efficiency
	Run #1	Run #2	Run #3	Average	Run #1	Run #2	Run #3	Average	
gas flow (kdscfm)	1,135	1,053	1,008	**1,065**	1,122	1,126	1,149	**1,132**	
gas temperature (°F)	324	317	320	**320**	180	179	177	**179**	
% isokinetic	104	109	105	**106**	99	100	99	**99**	
Pollutant Data									
particulate (gr/dscf)	2.1	2.4	2.6 [1]	**2.4**	2.7e-3	1.1e-2	8.0e-3	**7.2e-3**	**99.7%**
elemental Hg (µg/dscm)	8.4	6.8	8.7 [1]	**7.9**	7.2	7.1	7.1	**7.1**	**9.7%**
particulate Hg (µg/dscm)	1.8	2.2	1.7 [1]	**1.9**	3.8e-2	3.6e-2	3.5e-2	**3.6e-2**	**98.1%**
oxidized Hg (µg/dscm)	2.8	3.4	2.7	**3.0**	4.8e-2	1.2e-1	1.8e-1	**1.2e-1**	**96.1%**
total Hg (µg/dscm)	13.1	12.3	13.1	**12.8**	7.2	7.3	7.3	**7.3**	**43.4%**
particulate (lb/hr)	20,318	21,313	22,610 [1]	**21,414**	26	105	79	**70**	
elemental Hg (lb/hr)	3.6e-2	2.7e-2	3.3e-2 [1]	**3.2e-2**	3.0e-2	3.0e-2	3.1e-2	**3.0e-2**	
particulate Hg (lb/hr)	7.8e-3	8.6e-3	6.6e-3 [1]	**7.7e-3**	1.6e-4	1.5e-4	1.5e-4	**1.5e-4**	
oxidized Hg (lb/hr)	1.2e-2	1.3e-2	1.0e-2	**1.2e-2**	2.0e-4	4.9e-4	7.7e-4	**4.9e-4**	
total Hg (lb/hr)	5.5e-2	4.9e-2	4.9e-2	**5.1e-2**	3.0e-2	3.1e-2	3.2e-2	**3.1e-2**	

[1] - Data subject to unknown (but likely small) negative bias due to container breakage

Table 5.1: Testing Results